New Hampshire Volunteer Lake Assessment Program

2003 Biennial Report for Spofford Lake Chesterfield



NHDES
Water Division
Watershed Management Bureau
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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **SPOFFORD LAKE, CHESTERFIELD,** the program coordinators have made the following observations and recommendations:

As you are aware, the Franklin Pierce College (FPC) satellite VLAP laboratory was not able to analyze samples during the 2003 sampling season. This was largely due to personnel and budget issues at the college. Although the FPC laboratory was not able to analyze samples, staff at FPC continued to lend out sampling equipment to volunteer monitors in this areas. This was truly a cooperative effort between DES, FPC, and the volunteer monitors in this region. We want to thank you again for bearing with us this season. Also, we want to assure you that DES and FPC are working together to get the FPC lab up and running for the 2004 sampling season. We will keep you posted on the status of the laboratory as the sampling season approaches.

Thank you for your continued hard work sampling the lake/pond this season! Your monitoring group sampled **three** times this season and has done so for many years! As you know, with multiple sampling events each season, we will be able to more accurately detect changes in water quality. Keep up the good work!

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

  Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 ug/L.**

The current year data (the top graph) show that the chlorophyll-a concentration ***increased very gradually*** from June to August. The chlorophyll-a concentration on each sampling event was ***much less than*** the state mean.

Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual chlorophyll-a concentration has ***not significantly changed*** (either *continually increased* or *continually decreased*) since **1990**. (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake/pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

  Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

  The current year data (the top graph) show that the in-lake transparency ***remained relatively stable*** from June to August. The transparency on each sampling event was ***greater than*** the state mean.

Overall, the statistical analysis of the historical data show that the transparency has ***significantly decreased*** since monitoring began. Specifically, the in-lake transparency has ***decreased*** (meaning ***worsened***) on average by ***approximately 1.8 percent*** per sampling season during the sampling period **1990** to **2003**. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

  The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***increased slightly*** from June to July, and then ***remained stable*** from July to August. The phosphorus concentration on each sampling event was ***less than*** the state median.

  The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased consistently*** from June to August. The phosphorus concentration in August was ***greater than*** the state median.

  The historical data show that the 2003 mean hypolimnetic phosphorus concentration is ***approximately equal to*** the state median.

Overall, the statistical analysis of the historical data show that the phosphorus concentration in the epilimnion (upper layer) and the hypolimnion (lower layer) has ***not significantly changed*** since **1990**. Specifically, the phosphorus concentration in the epilimnion has remained ***relatively stable*** and has been ***less than*** the state median. The phosphorus concentration in the hypolimnion has ***fluctuated***, but has not *continually increased* or *decreased* since monitoring began. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

  Table 2 (Appendix B) lists the current and historic phytoplankton species observed in the lake/pond. The dominant phytoplankton species observed in the June plankton sample this year were ***Cosmarium*** **(a green algae),** ***Xanthidium*** **(a green algae),** ***and Ceratium*** **(a dinoflagellate).**

  Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

- **Table 2: Cyanobacteria (Blue-green algae)**

  Small amounts of the cyanobacterium ***Microcystis*** was observed in the plankton sample this season. ***This species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.***

  Cyanobacteria can reach nuisance levels when excessive nutrients and favorable environmental conditions occur. During September of 2003, a few lakes and ponds in the southern portion of the state experienced cyanobacteria blooms. This was likely due to nutrient loading to these waterbodies. As mentioned previously, many weeks during the Spring and Summer of 2003 were rainy, which likely resulted in a large amount of nutrient loading to surface waters.

The presence of cyanobacteria serves as a reminder of the lake's/pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake/pond by eliminating fertilizer use on lawns, keeping the lake/pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

- **Table 4: pH**

  Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

  pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.5**, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

  The mean pH at the deep spot this season ranged from **6.50** in the hypolimnion to **6.88** in the epilimnion, which means that the water is ***slightly acidic.***

  Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

- **Table 5: Acid Neutralizing Capacity**

  Table 5 (Appendix B) presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire's lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are "highly sensitive" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) was 8.40 mg/L, which is ***slightly greater*** than the state mean. However, the lake is still classified as being ***highly sensitive*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**

Table 6 (Appendix B) presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire's lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The conductivity has ***increased*** at the deep spot the lake/pond since monitoring began. Specifically, the mean annual epilimnetic concentration has ***increased*** (meaning *worsened*) by ***approximately 2.3 percent*** per sampling season during the sampling period **1990** to **2003**. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

The mean annual conductivity in ***Shield Inlet*** has ***increased*** since monitoring began. In addition, the conductivity has ***fluctuated***, but has generally been ***high*** in **Camp Inlet, Seamans Inlet, and Wares Grove Inlet**. Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

Spofford Lake is bordered by Route 9 to the south and Route 63 to the west. It is possible that de-icing materials applied to these roadways during the winter months may be influencing the conductivity in the tributaries and in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride). On the June sampling event, chloride samples were taken in **Wares Grove** (37 mg/L), **Shield Inlet** (28 mg/L), **Seamans Inlet** (116 mg/L), and **Camp Inlet** (42 mg/L). These data indicate that elevated levels of chloride are present in the tributaries that flow into the lake. The Spofford Lake Association has approached the Department of Transportation about reducing the amount of road salt applied to these roadways.

- **Table 8: Total Phosphorus**
  Table 8 (Appendix B) presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The total phosphorus concentration was ***elevated*** in **Seamans Inlet (83 ug/L) and Shield Inlet (93 ug/L)** on the July sampling event. The turbidity (Table 11) of these samples, as well as the **Camp Inlet** sample, were also ***elevated*** (6.16, 4.7, and 4.56 NTUs respectively). The volunteer monitors indicated on the field data sheet that these tributaries were barely flowing and that a lot of sediment was collected in the bottle. When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting samples in the inlets, please be sure to sample where there the stream is flowing and where the stream is deep enough to collect a "clean" sample.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was ***very high*** at all depths sampled at the deep spot of the lake/pond. In fact, the oxygen concentration was *much greater than 100 percent saturation* from the surface to the beginning of the hypolimnion. Layers of algae can raise the dissolved oxygen in the water column since oxygen is a by-product of photosynthesis. Wave action from wind can also dissolve atmospheric oxygen into the upper layers of the water column. It is also possible that the oxygen probe was not functioning properly.

  During many past sampling seasons the lake/pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of ***internal total phosphorus loading*** (commonly referred to as ***internal loading***) is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(as it has been in August of previous sampling seasons)**, the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column. Depleted oxygen concentration in the hypolimnion of thermally stratified lakes/ponds typically occurs as the summer progresses.

Internal loading may explain why the phosphorus concentration in the hypolimnion is ***greater*** than the phosphorus concentration in epilimnion as the summer progresses. Since an internal source of phosphorus in the lake/pond may be present, it is even more important that watershed residents act proactively to minimize external phosphorus loading from the watershed.

- **Table 11: Turbidity**
  Table 11 (Appendix B) lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  As discussed previously, the turbidity was elevated in **Seamans Inlet, Shield Inlet, and Camp lnlet** on the July sampling event, likely due to the stream bottom being disturbed while sampling.

- **Table 12: Bacteria (*E.coli*)**
  Table 12 lists the current year data for bacteria (*E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **MAY** be present. If sewage is present in the water, potentially harmful disease-causing organisms may also be present. Please consult the "Other Monitoring Parameters" section of the report for the current state standards for *E. coli* in surface waters. If residents are concerned about sources of bacteria such as failing septic systems, animal waste, or waterfowl waste, it is best to conduct *E. coli* testing when the water table is high, when beach use is heavy, or after rain events.

  Extensive *E.coli* sampling was conducted on the June and August sampling events this season. Many inlets and beaches were tested. Overall, the *E.coli* results this season were ***relatively low***. Most results were 30 counts per 100 mL or less, which is much *less than* the state standard of 88 counts per 100 mL for designated public beaches.

However, as with the 2002 sampling season, the highest ***E.coli*** result was measured at **Clarkdale Pipe**. On the August 26 sampling event this season, the concentration was 130 counts per 100 mL. (On the July 16, 2002 sampling event the *E.coli* concentration at this station was 54 counts per 100 mL.) We recommend that this location be sampled during and immediately after a storm event. In addition, we recommend that a stream survey be conducted in this area. These additional sampling activities may help us to pinpoint the sources of elevated *E.coli.*

In addition, if you are particularly concerned about the *E. coli* levels at any of the beaches, we recommend that your monitoring group conduct sampling on a weekend during heavy beach use or after a storm event. Since bacteria die quickly in cool pond waters, testing is most accurate and most representative of the health risk to bathers when the source (humans, animals, or waterfowl) is present.

For a detailed explanation on how to conduct storm event sampling, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake/pond, the biologist conducted a "Sampling Procedures Assessment Audit" for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor's Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did a ***very good*** job when collecting samples this season! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures when collecting and submitting samples to the laboratory. However, the laboratory did identify one aspect of sample collection that the volunteer monitors could improve upon.

- **Tributary Sampling:** Please do not sample tributaries that are too shallow to collect a "clean" sample and do not sample the stream if the stream bottom has been disturbed. You may need to move upstream or downstream to collect a "clean" sample. If you disturb the stream bottom while sampling, please rinse out the bottle and move to an upstream location and sample in an undisturbed area.

NOTES

- **Monitor's Note (7/29/03):** Seaman's, Shield, and Camp Spofford Inlet were barely flowing. Lots of sediment in these samples. E. Coli samples being tested at EA

- **Biologist's Note (7/29/03):** The total phosphorous levels at Seaman's Inlet and Shield Inlet were found to be high.

  (8/26/03): The total phosphorous level at the hypolimnion was slightly elevated, which could indicate internal loading. In addition, the E. Coli counts at Clarkdale Pipe were high.

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, ARD-32, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, *NHDES-WD 97-8*, NHDES Booklet, (603) 271-3503.

Camp Road Maintenance Manual: A Guide for Landowners. KennebecSoil and Water Conservation District, 1992, (207) 287-3901.

Comprehensive Shoreland Protection Act, RSA 483-B, WD-SP-5, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-5.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-1.htm

Impacts of Development Upon Stormwater Runoff, WD-WQE-7, NHDES Fact Sheet, (603) 271-3503, or www.des.state.nh.us/factsheets/wqe/wqe-7.htm

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, *WD-BB-9*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Management of Canada Geese in Suburban Areas: A Guide to the Basics, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, WD-WMB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

Sand Dumping - Beach Construction, *WD-BB-15*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

Swimmers Itch, *WD-BB-2*, NHDES Fact Sheet, (603) 271-3503 or *www.des.state.nh.us/factsheets/bb/bb-2.htm.*

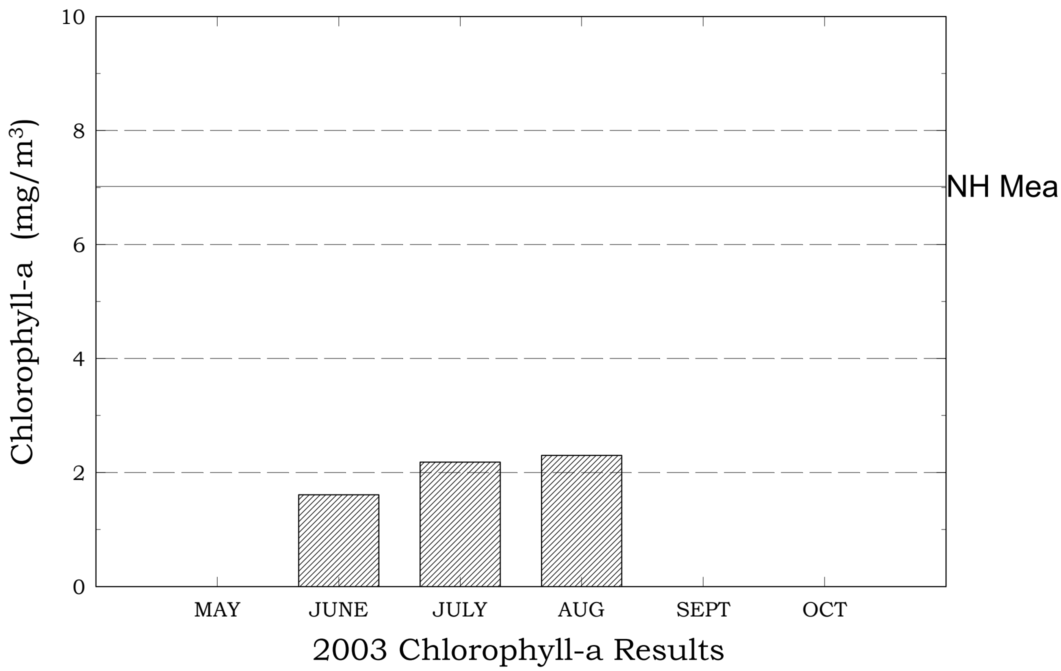
Through the Looking Glass: A Field Guide to Aquatic Plants. North American Lake Management Society, 1988, (608) 233-2836 or www.nalms.org.

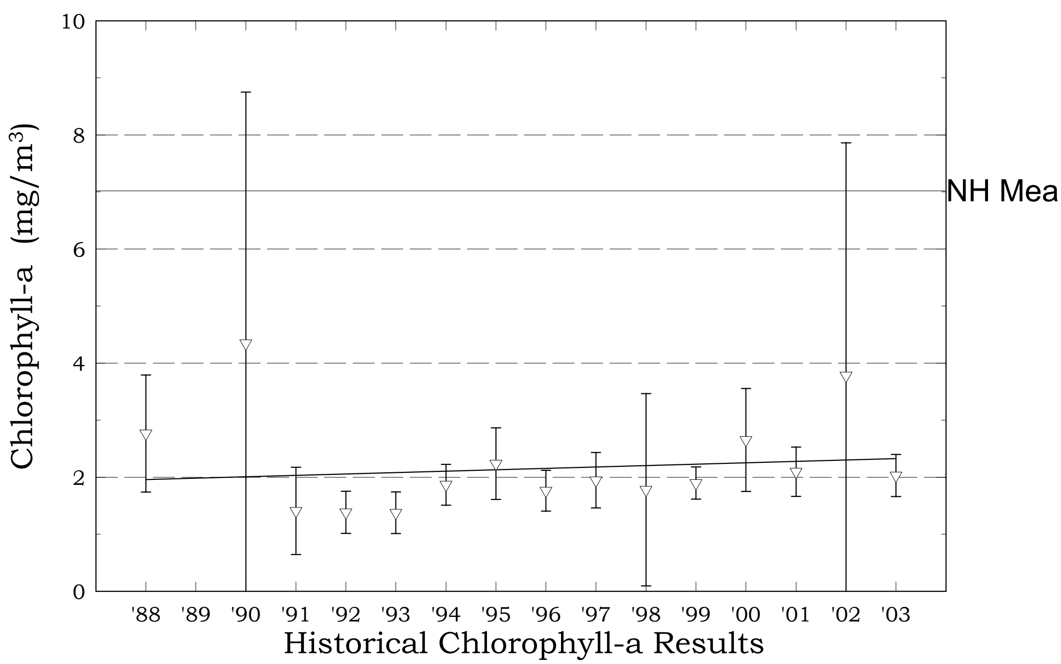
APPENDIX A

GRAPHS

Spofford Lake, Chesterfield

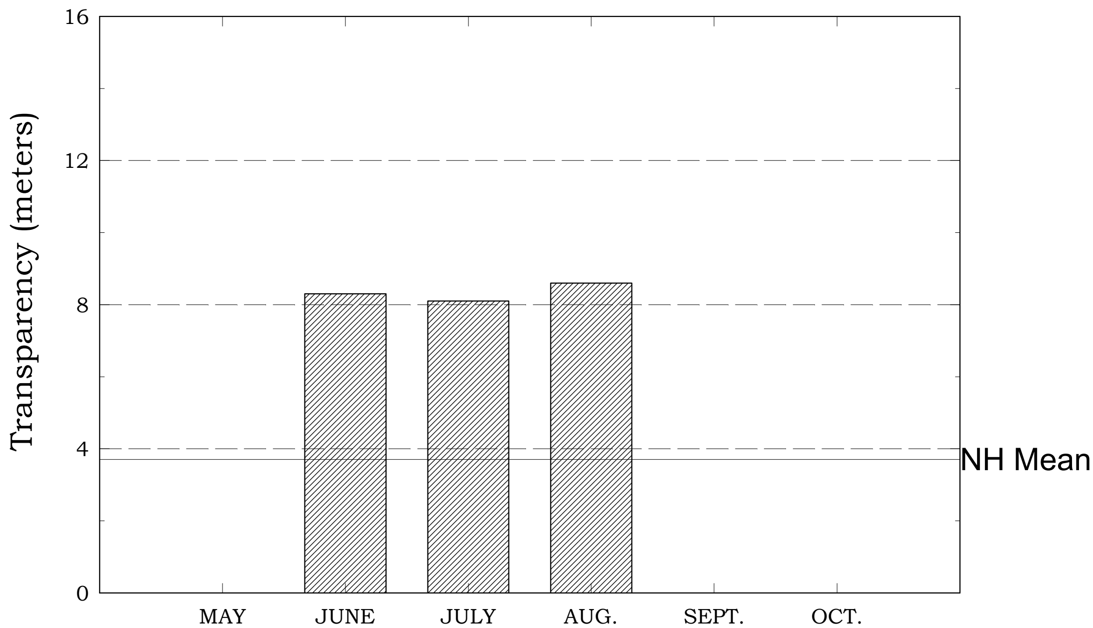
Figure 1. Monthly and Historical Chlorophyll-a Results



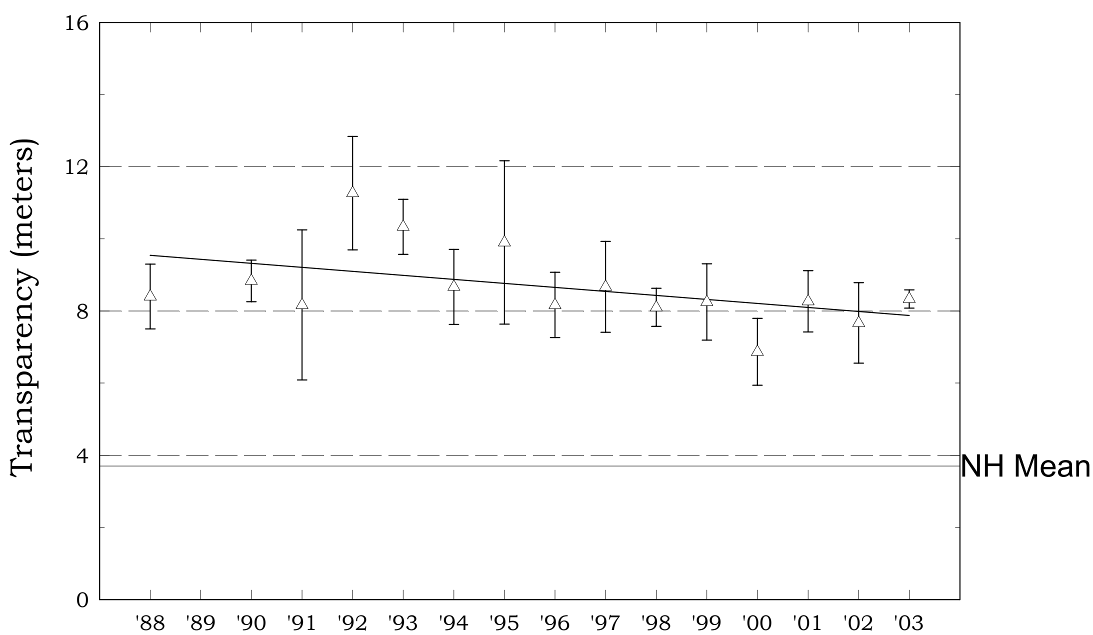


Spofford Lake, Chesterfield

Figure 2. Monthly and Historical Transparency Results



2003 Transparency Results



Historical Transparency Results

Spofford Lake, Chesterfield

Figure 3. Monthly and Historical Total Phosphorus Data.